

# Distribution of soil corrosion grade in Southern Hebei Province

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**Abstract.** Transmission towers and substations are used in a variety of natural environments, coupled with the interference of the surrounding production and life, facing the test of soil corrosion. Based on the experimental data of 72 soil samples from five cities in Southern Hebei Province, the soil resistivity, soil pH value and soil moisture content were investigated, and the soil corrosion grade and soil corrosion grade distribution map were obtained. It provides a reference for the collection of soil corrosivity data in power transmission and transformation projects.

**Keywords:** Soil erosion; Soil resistivity; Regional distribution; Hebei province; Soil pH.

## 1 Introduction

With the rapid development of China's economy, the scale of power construction has increased sharply. As an important part of power grid operation, the service safety of transmission towers and substations has attracted more and more attention. The above equipment is used in a variety of natural environments, coupled with the interference of the surrounding production and life, it is very likely that the materials will be damaged and failed in advance due to soil corrosion, which will affect the safe and efficient operation of the key equipment of power transmission and transformation. Hebei Southern Power Grid (including Shijiazhuang, Baoding, Cangzhou, Hengshui, Xingtai and Handan) covers a complex environment with different soil corrosion risks. Therefore, it is necessary to collect soil corrosivity data for power transmission and transformation project.

## 2 Experiment

In this study, 72 stations in five cities of Southern Hebei Province were sampled by the principle of on-site sampling packaging and centralized measurement in laboratory. The soil resistivity was measured by FUZZR FR3010E resistivity meter. Then, digging out a pit with a depth of about 60cm and diameter of 40cm at the collection point, and sampled 1kg.

Take about 20g of sample soil, crush it, quickly put it into a large aluminium box with known accurate mass  $M_0$ , cover it tightly, wipe the surface of the aluminium box clean, and weigh it to get the initial mass  $M_1$ . Remove the lid of the box, put it under the box, and bake

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it in the oven preheated to  $105 \pm 2 \text{ }^\circ\text{C}$  for 12h. Take it out, cover it, cool it to room temperature in a dryer (about 30 min), and weigh it immediately to get  $m_2$  [1]. The soil moisture content can be obtained by Formula 1.

$$A, \% = \frac{m_1 - m_2}{m_1 - m_0} \times 100 \tag{1}$$

Take appropriate amount of soil samples, spread them evenly, air dry at room temperature for 24 hours, grind them and pass through a sieve with a diameter of 1 mm. Take 10g of air-dried soil sample after sieving, put it into a 50ml beaker, add 25ml of deionized water, stir for 1 minute to make the soil particles fully disperse, and then use a pH meter to determine after standing for 30 minutes [2].

The physical and chemical properties of soil samples were sorted out, and the degree of soil corrosion was graded by using three kinds of data. The soil corrosion evaluation system of three index method is shown in Figure 1. According to the results, the soil is divided into five grades, and the soil corrosivity is gradually strengthened.

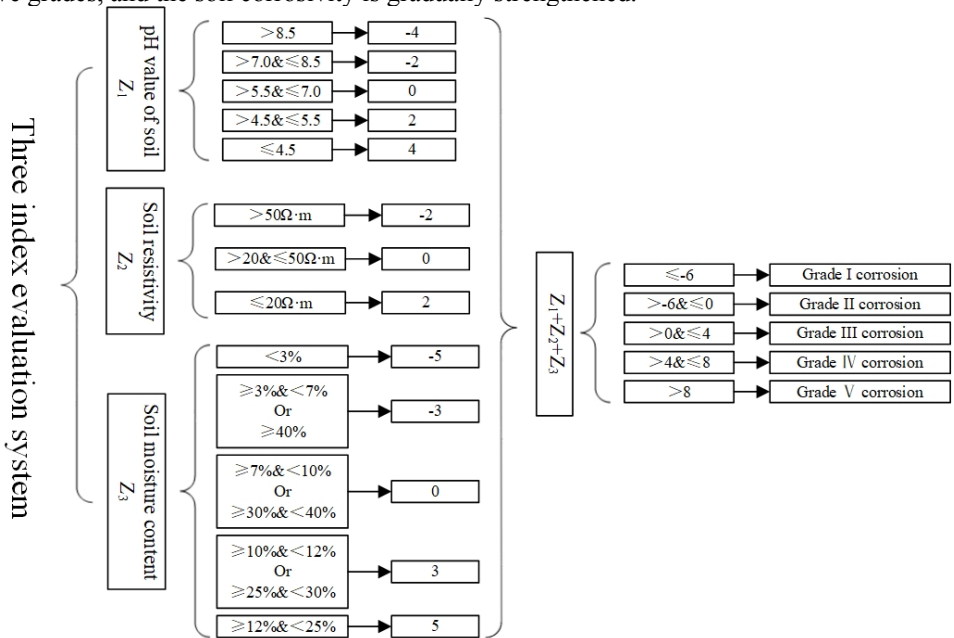


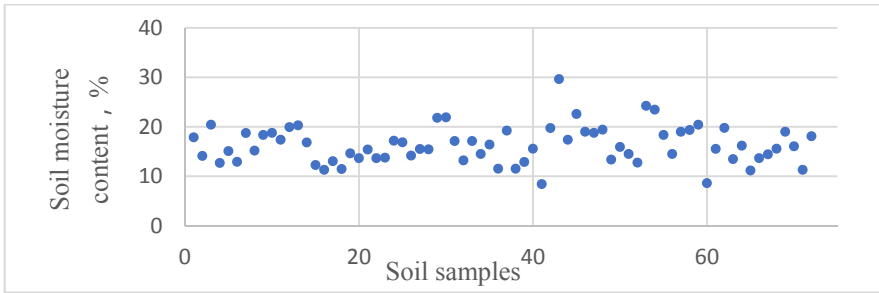
Fig. 1. Evaluation block diagram of three index method.

### 3 Result

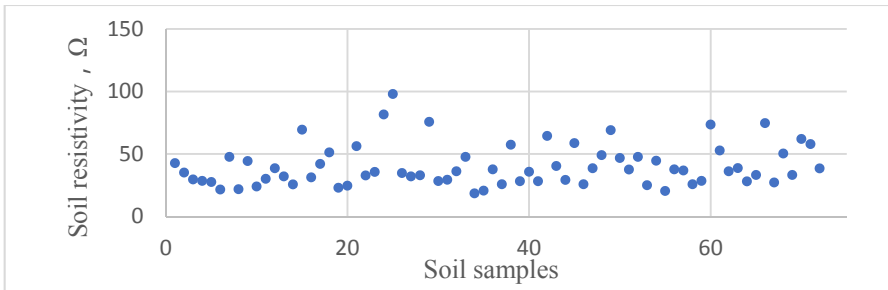
#### 3.1 Soil moisture content

The moisture content of soil is an important factor affecting the corrosion of metal materials.[3] When the moisture content is very high or very low, the corrosion rate is the lowest. The corrosion rate of metals increases first and then decreases with the increase of water content. When the soil water content is about 20%, the corrosion rate is the highest. [4-7] In addition, the size of soil moisture also has an impact on soil resistivity. [8-9]

The moisture content of soil samples at each station is shown in Figure 2. It can be seen that the moisture content of most stations is concentrated in the range of 12% - 25%, and the soil corrosion capacity is increased due to the moisture content in this range.



**Fig. 2.** Soil moisture distribution map of each station.



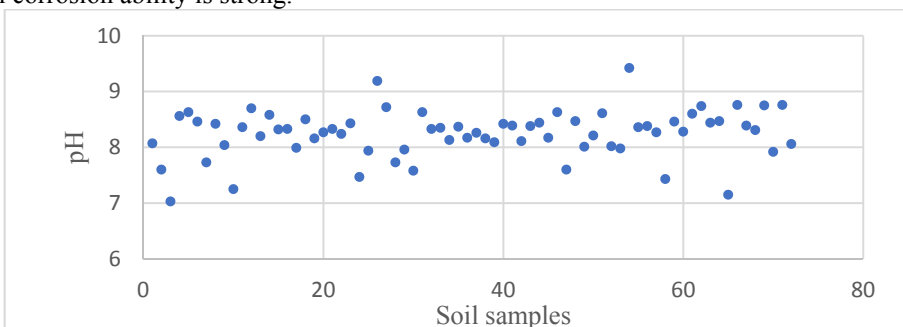
**Fig. 3.** Distribution of soil resistivity at each station.

### 3.2 Soil resistivity

For the common medium alkaline soil, the soil corrosivity increases with the decrease of resistivity. But for acid soil, the soil resistivity is high, and the corrosion is also serious. The soil resistivity of each station is shown in Figure 3. It can be seen that the soil resistivity of most stations is concentrated in 20-50 Ω section.

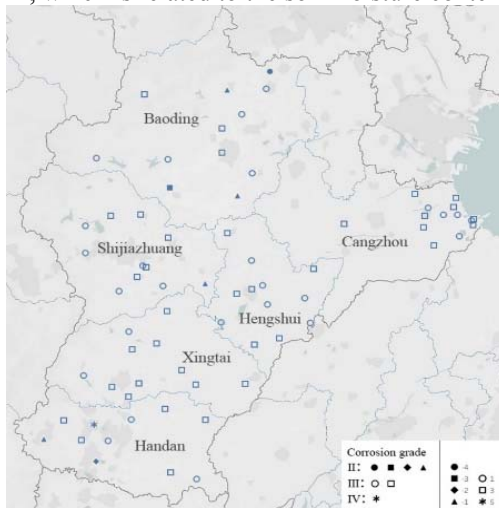
### 3.3 Soil pH value

The pH test results of soil samples at each site are shown in Figure 4. It can be seen that the pH value of most sites is in the range of weak alkalinity to alkalinity. With the increase of soil pH, the concentration of hydrogen peroxide in soil increases, and the depolarization of oxygen becomes the main cathodic reaction. When the depolarization of  $O_2$  becomes the control step, the cathodic reaction rate accelerates, the dissolution rate of anode metal accelerates, and the corrosion aggravates. The pH value of some stations is above 9, and the soil corrosion ability is strong.



**Fig. 4.** Distribution of soil pH value at each station.

Using the three-index evaluation system, the data and map are combined to get the results shown in Figure 5. Most of the sites are in the third grade of soil corrosion, which has a certain correlation with the industrial distribution of local cities. The sampling sites are located in the industrial concentration area, and the soil corrosivity is strong. In coastal areas, the corrosion is grade III, which is related to the soil moisture content and strong alkalinity.



**Fig. 5.** Corrosion grade map.

## 4 Conclusion

There are many factors affecting the soil corrosion rate. This paper focuses on soil moisture content, soil resistivity and soil pH value. Based on the analysis of 72 soil samples from five cities in Southern Hebei Province, it is found that the soil corrosion in this area is characterized by "mild in the north and severe in the South". From the local point of view, the area with more serious soil corrosion is related to the concentration of heavy industry around the sampling point. The grade of soil corrosion in coastal areas is grade III. Soil water content and soil alkalinity play an important role in it. For the substation located in the area with high soil corrosion rate, the protection of grounding grid should be strengthened.

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